Rapid Response tools and datasets for post-fire modeling applied to the
Horse River Fire in Fort McMurray

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Forest Service Partners:

Bill Elliot, PE, PhD and Pete Robichaud, PE, PhD

USFS Rocky Mt Research Station, Moscow, ID

Collaborator:

Lee MacDonald, Colorado State University

Introduction

- Forests provide many products as well as ecosystem services
  - Wood
  - Wildlife and fish habitat
  - Recreation
  - Clean water

Forest in Northern Idaho

- Wildfire impacts on watersheds
  - Increased peak flow rates (up to 100x)
  - Increased sediment delivery to streams (up to 1000x)

Waiting for the flood after an Arizona fire

BAER Teams
(Burned Area Emergency Response)

- Mission: Protect lives, property and natural resources threatened by post-fire flooding and erosion.

- BAER Teams go to work before the fire is out.

- Treatments need to be completed before a major storm in order to be effective.

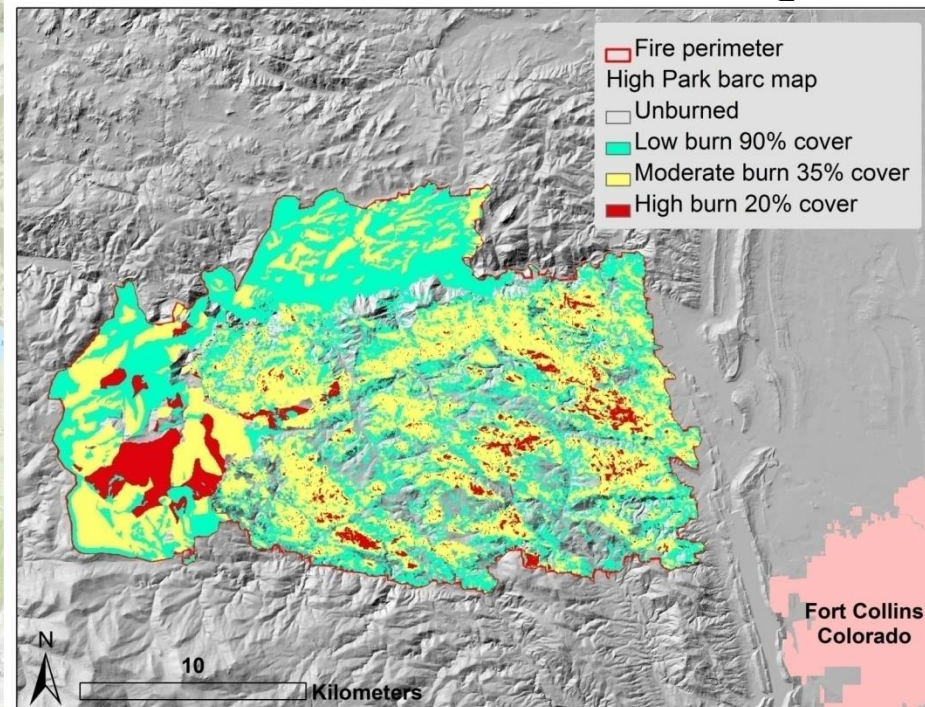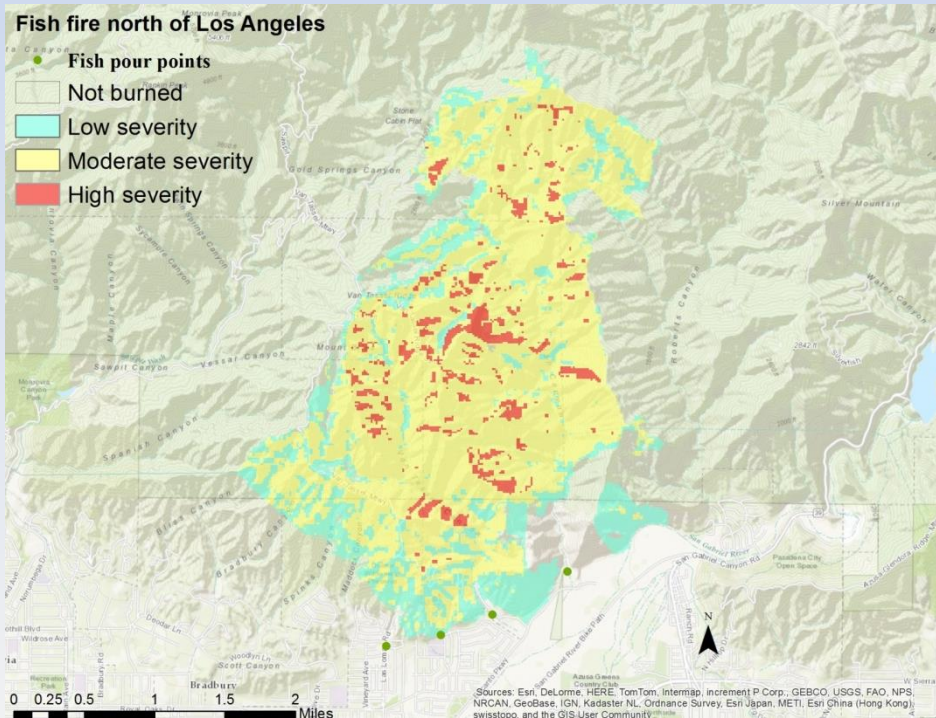# WEPP (**W**ater **E**rosion **P**rediction **P**roject) Watershed Erosion Model
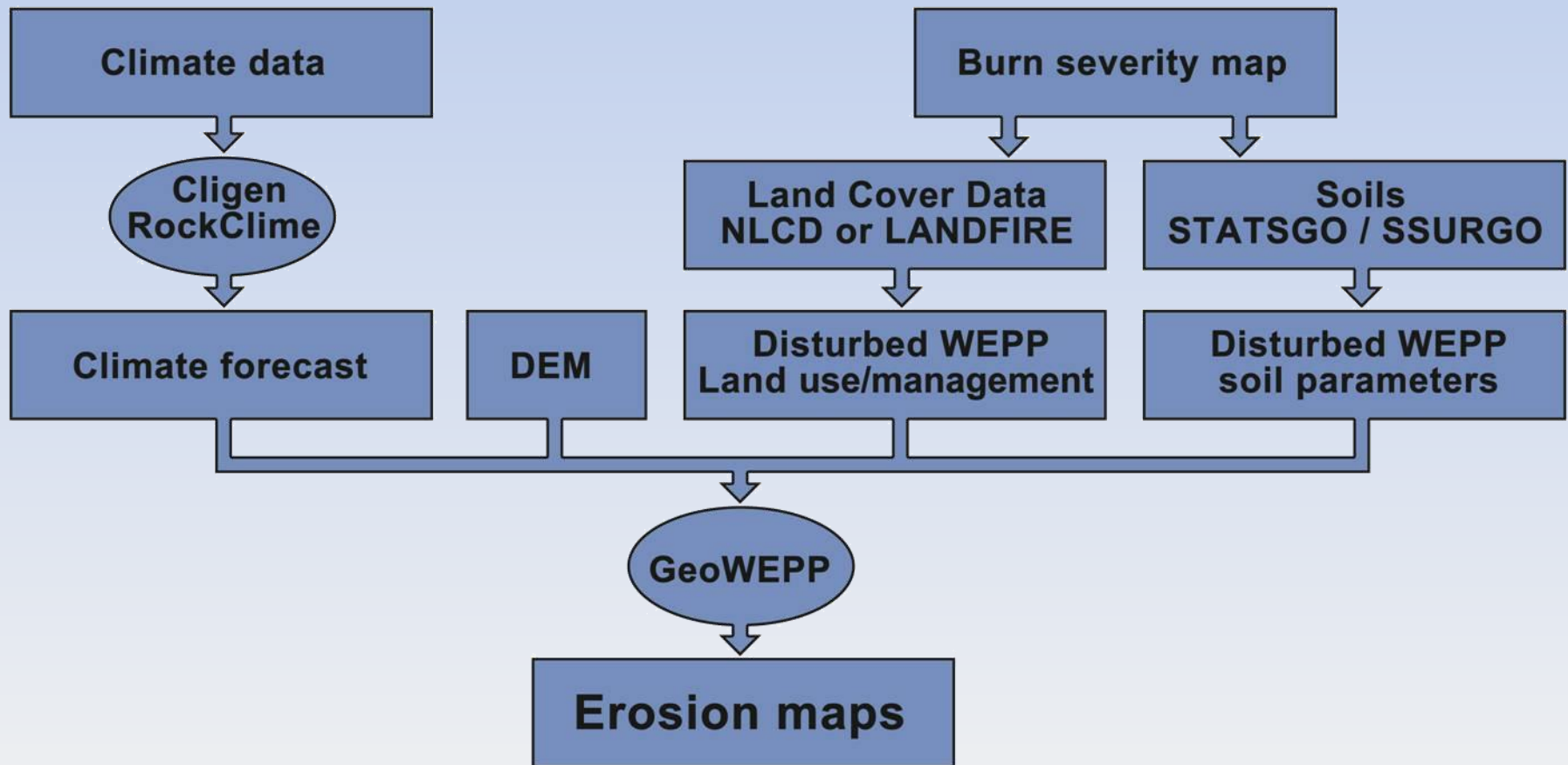
Remote Sensing Data

$$NBR = (R_{NIR} - R_{SWIR}) / (R_{NIR} + R_{SWIR})$$

Where: R is the reflectance at the satellite in either the near-infrared (NIR) or the shortwave-infrared (SWIR). The change in NBR between the pre- and post-fire conditions is calculated by:

$$dNBR = NBR_{prefire} - NBR_{postfire}$$

Fish fire north of Los Angeles

- Fish pour points
- Not burned
- Low severity
- Moderate severity
- High severity

Sources: Esri, DeLorme, HERE, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS-User Community

0 0.25 0.5   1   1.5   2
Miles

- Fire perimeter
- High Park barc map
- Unburned
- Low burn 90% cover
- Moderate burn 35% cover
- High burn 20% cover

Fort Collins Colorado

10
Kilometers

Problem - Spatial process based erosion models are currently under utilized.

Rock House Fire
Date: April 9, 2011
Location: Fort Davis, TX
Size: 314,444 acres ; 127,250 ha
Hospital Canyon: 536 acres; 217 ha
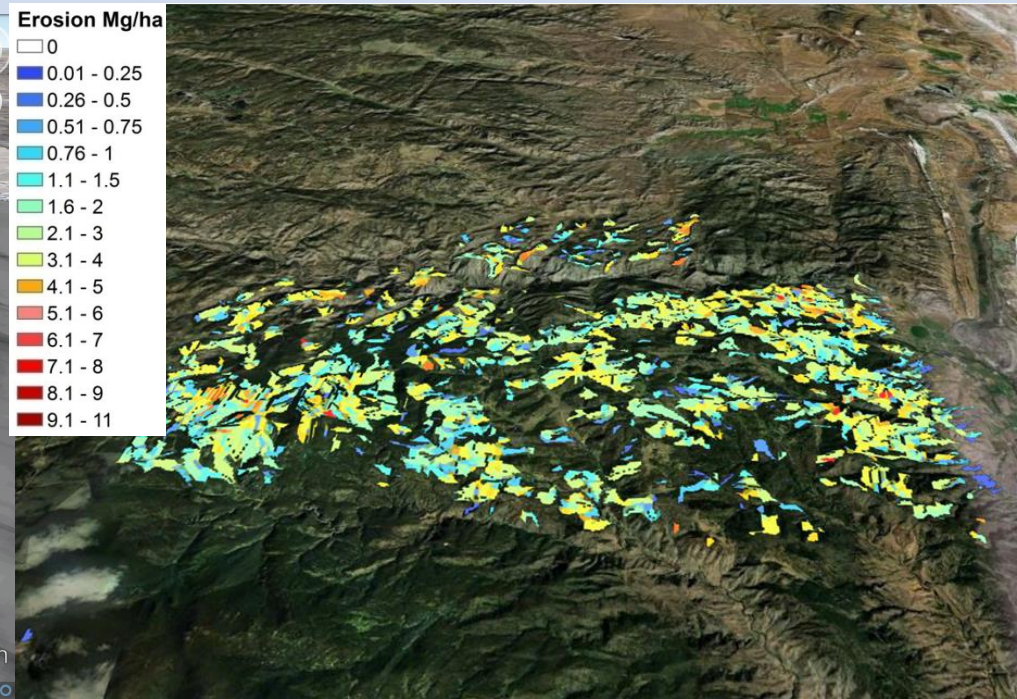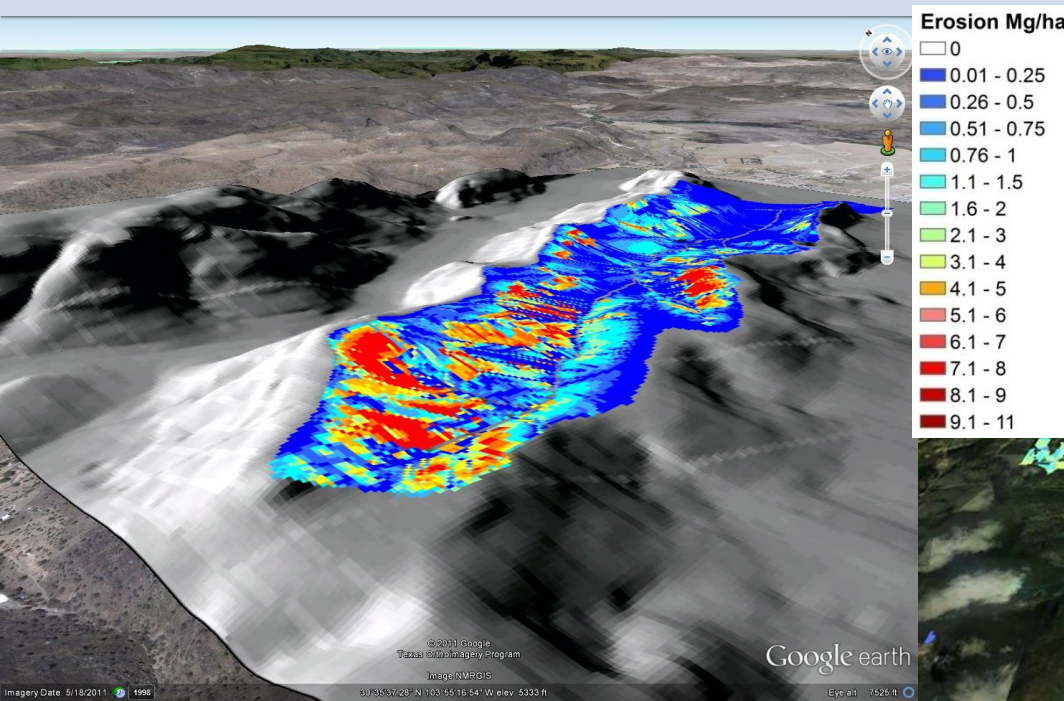BAER Team: National Park Service

High Park Fire
Date: June 9, 2012
Location: West of Fort Collins, CO
Size: 87,284 acres; 35,322 ha
BAER Team: Forest Service

http://geodjango.mtri.org/geowepp/

http://geodjango.mtri.org/geowepp/

NASA BAER database creates WEPP linkage files!
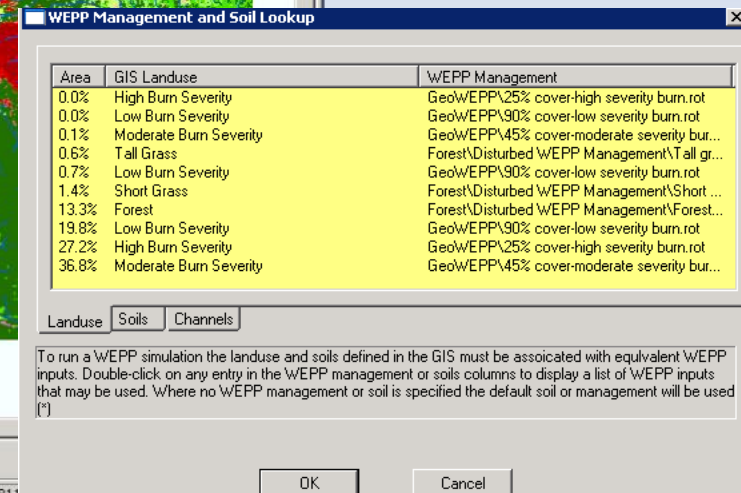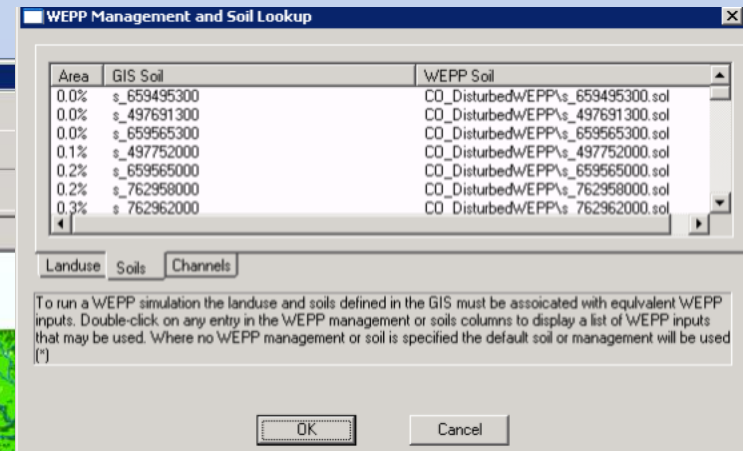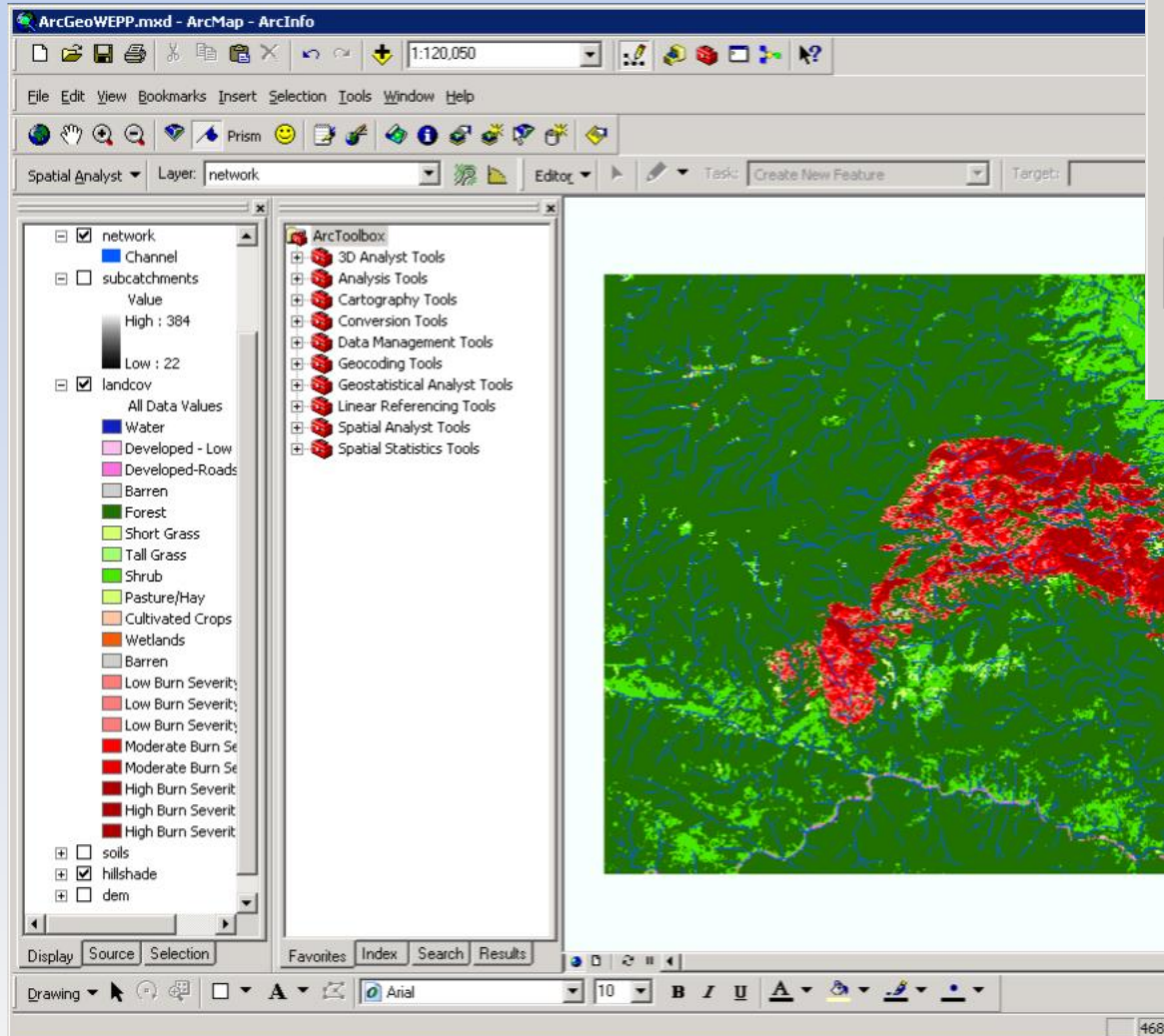
BAER Teams can focus on modeling!
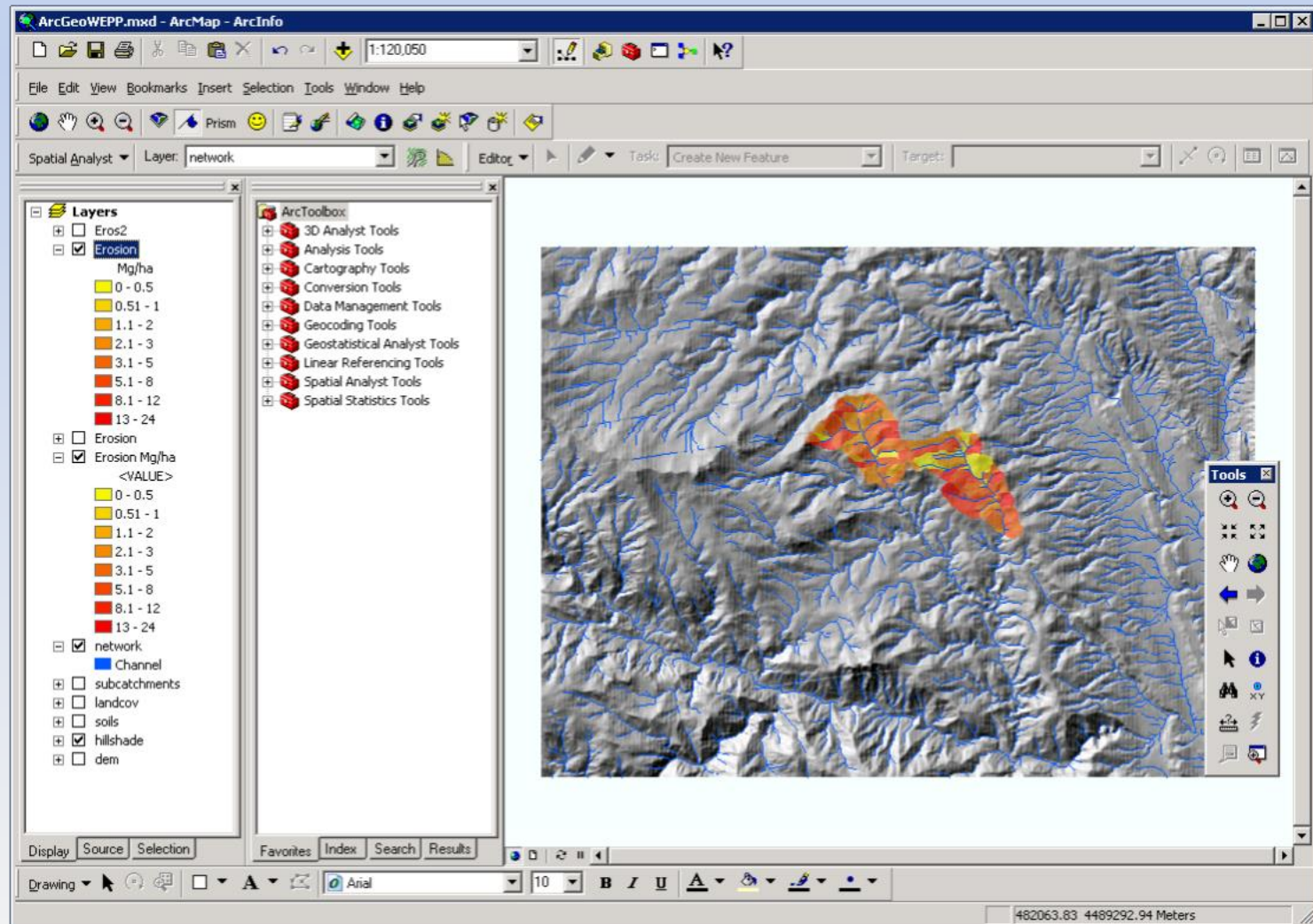
NASA BAER in Action!

for **Fuels Planning**
- Mokelumne
- Flagstaff

for **BAER Teams**
- Canyon Creek, OR
- Clearwater, ID
- Butte, CA
- Valley, CA
- French, CA
- Happy Camp, CA
- Silverado, CA
- King, CA
- Soberanes, CA
- Fish, CA
- Cedar, CA

for **Validation study**
- High Park, CO
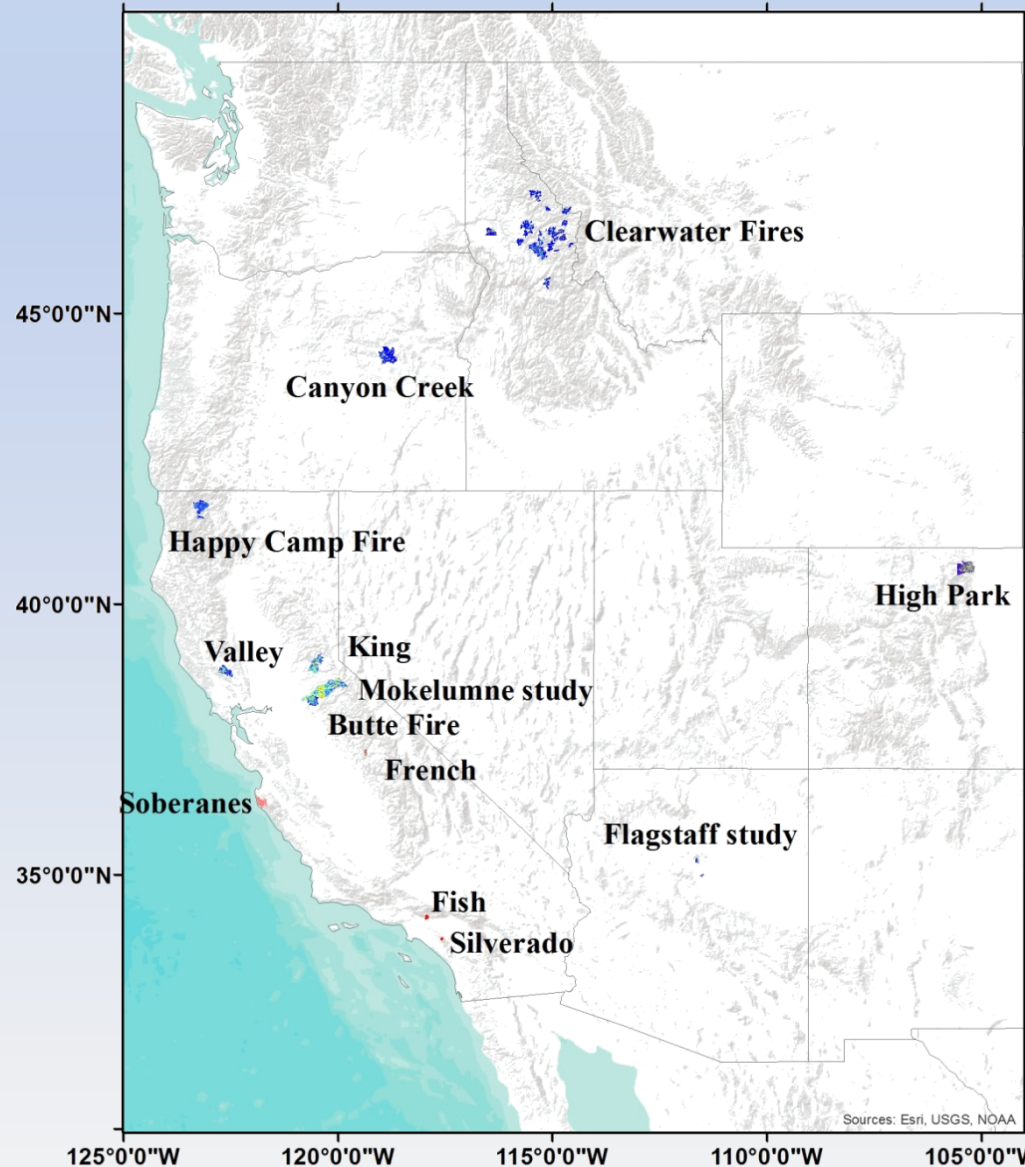
End User Feedback

"*For me, your erosion modeling and its use in analysis of treatment effects was the most necessary part of our mulch treatment decision-making process.*"
Jeff TenPas, Regional Soil Scientist and BAER Coordinator
USDA Forest Service – Pacific Southwest Region (R5)

"*Your WEPP research was a key input for the "Watershed Clearinghouse," a joint FEMA-State technical services group.*" Mary M Shaw FEMA Emergency Management Planner

We have three erosion control projects either underway or soon to begin:
• *"Our $3 million Wood Shred contract is out for bid, and I expect a contractor will be selected by the end of next week."*

Bill Haigh, Mother Lode Field Manager, BLM

Thank you very much, Mary! Super data; this will be extremely helpful. We are starting BARC checking in earnest today.

Pete Cafferata- Watershed Protection Program Manager, Forester III
California Department of Forestry and Fire Protection

Horse River Fire in Fort McMurray

- Horse River Fire burned through the town of Fort McMurray destroying 10% of the town

- largest wildfire evacuation in Alberta's history

- Burned from May 1 – July 5, 2016

- 590,000 hectares (1,500,000 acres)

- We coordinated our BAER response with: François-Nicolas Robinne - Western Partnership for Wildland Fire Science Department of Renewable Resources

RECOVER project dNBR map

Fort McMurray Fire

dNBR_HorseRiver_Fire.tif
High : 1.31242

Low : -0.566959

Miles
0   2.75 5.5   11   16.5   22
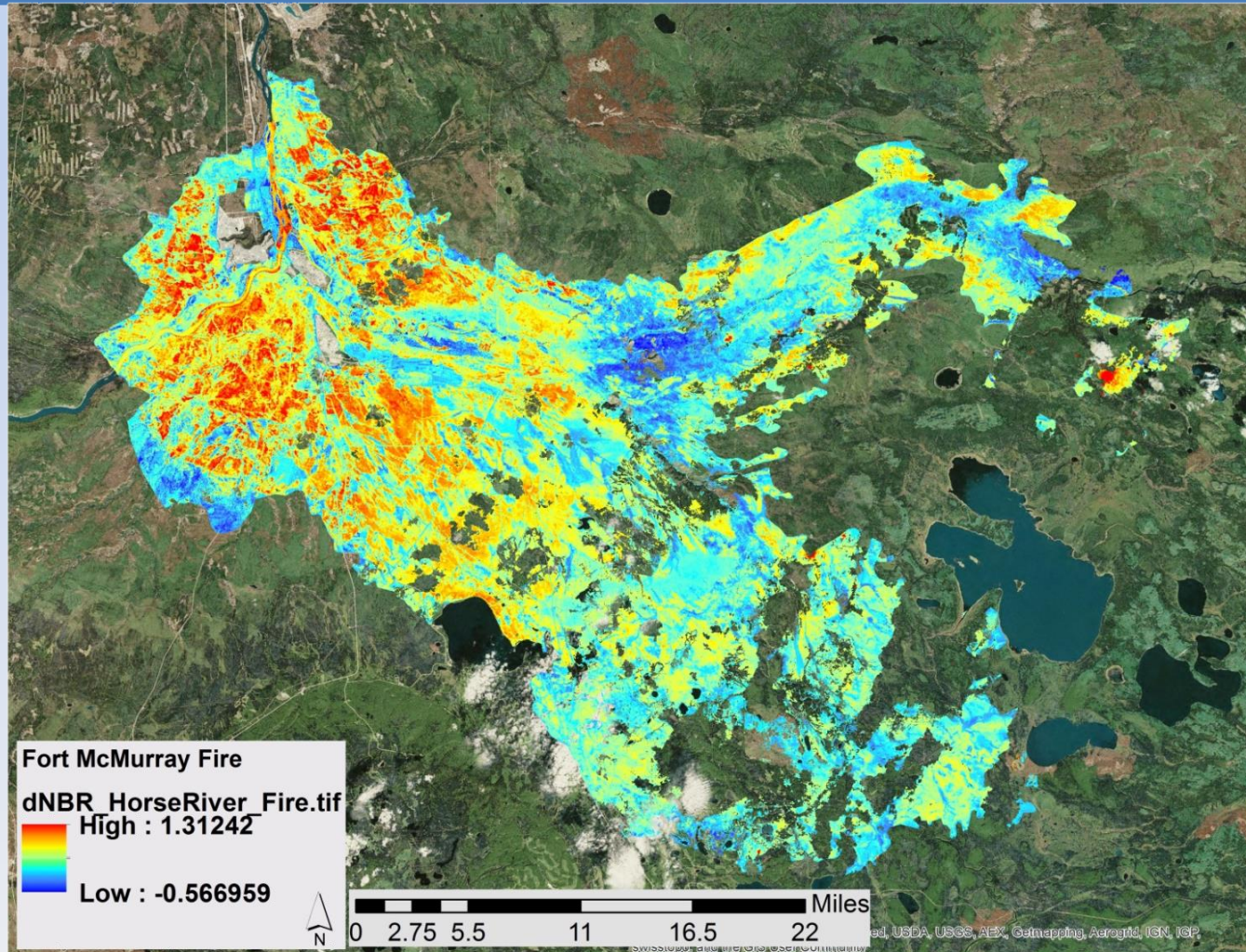
Schnase, John L., M. L. Carroll, K. T. Weber, Molly E. Brown, Roger L. Gill, Margaret Wooten, J. May et al. "RECOVER: An Automated, Cloud-Based Decision Support System for Post-Fire Rehabilitation Planning." *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences* 40, no. 1 (2014): 363.

Classified Burn Severity

Fort McMurray Fire
Burn Severity
- not burned
- low
- moderate
- high
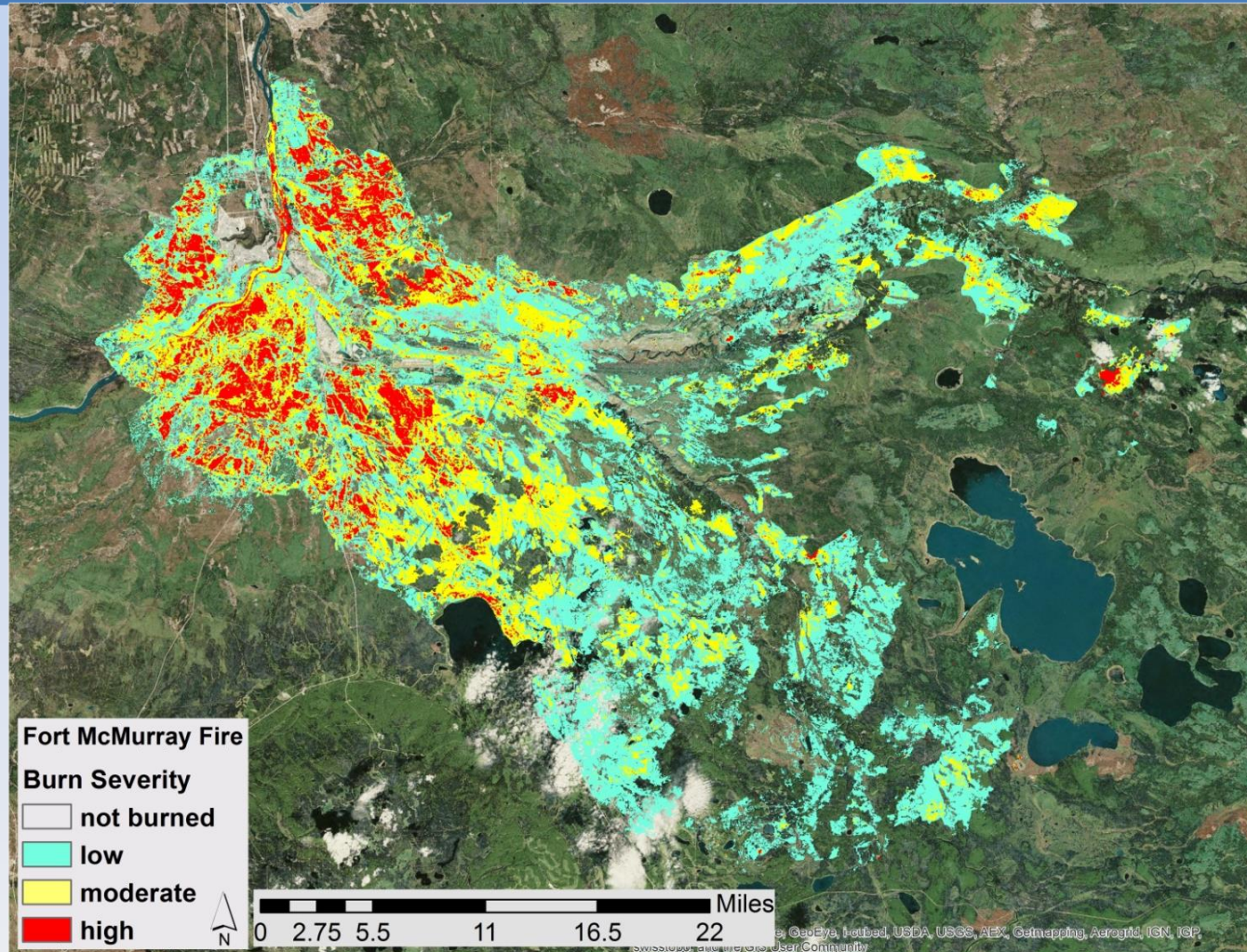
Hall, R. J., Freeburn, J. T., De Groot, W. J., Pritchard, J. M., Lynham, T. J., & Landry, R. (2008).
Remote sensing of burn severity: experience from western Canada boreal fires.
International Journal of Wildland Fire, 17(4), 476-489.

DEM
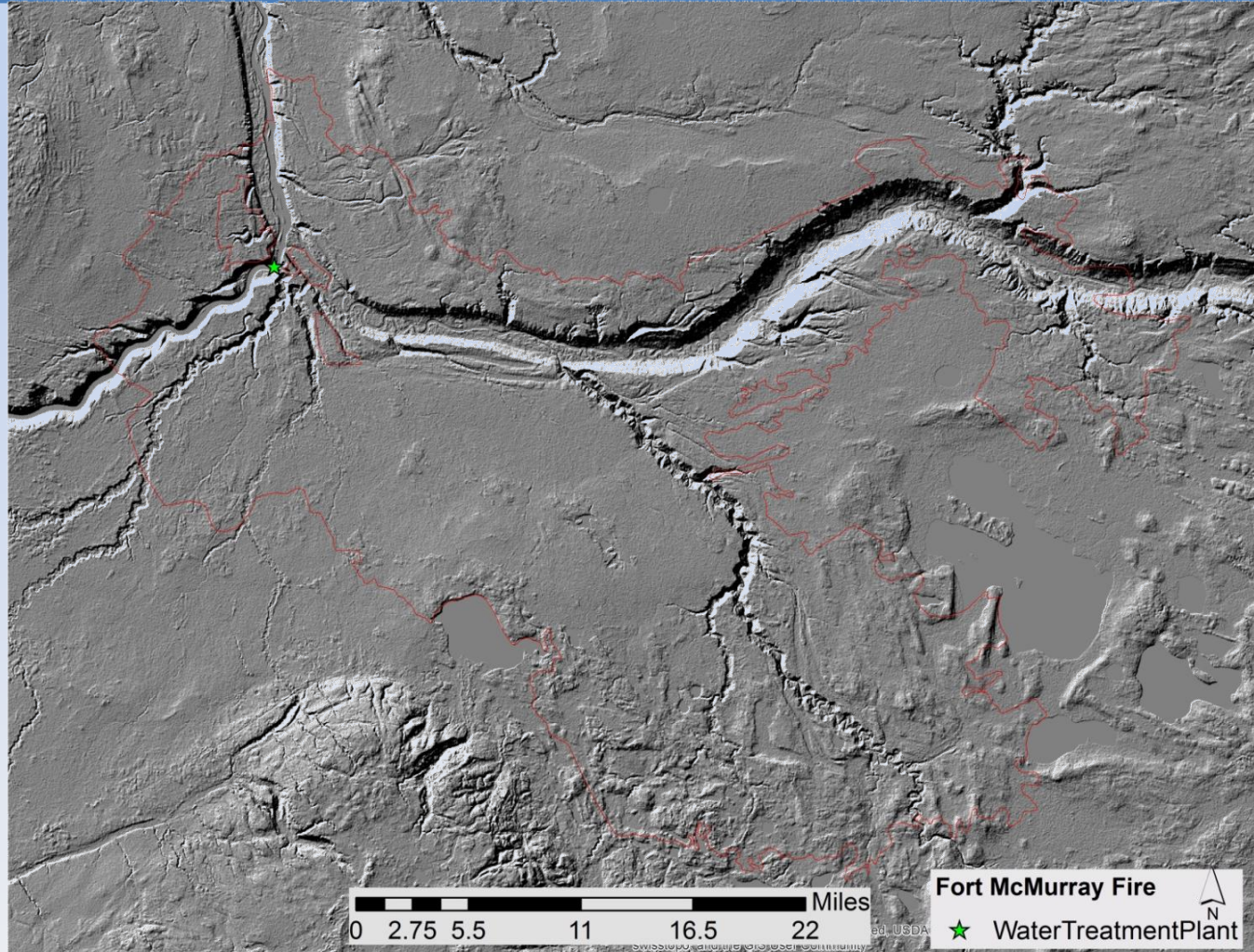
DEM data at a spatial resolution of 10 meters was made available to us through our Canadian colleague, François-Nicolas Robinne.

Post-fire Land Cover
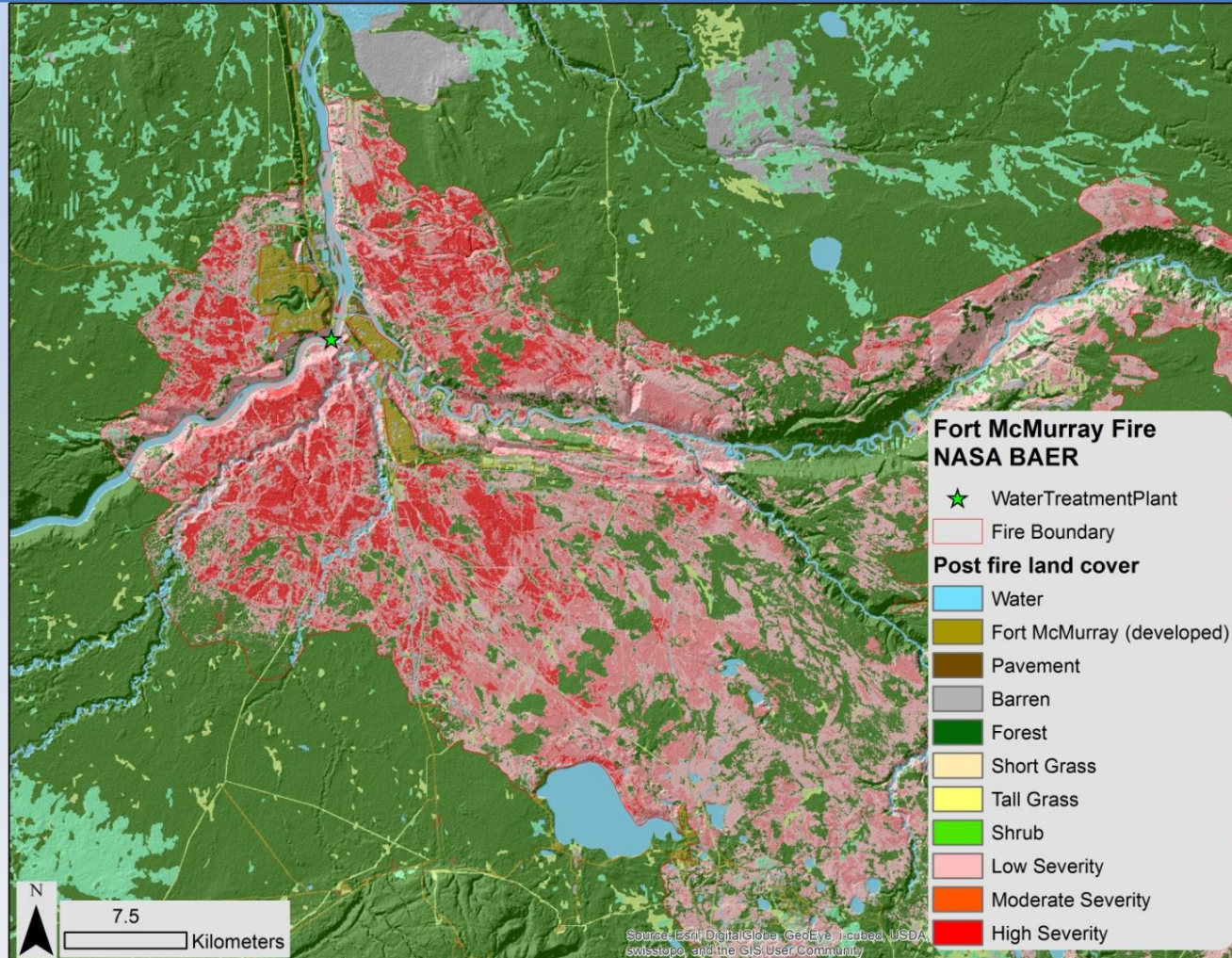
Alberta Biodiversity Monitoring Institute land cover map Low 85%. Mod 60%, High 25% (http://www.abmi.ca/home/data/gis-data/land-cover-inventory.html)

Canadian Soils

Canadian Soil Landscapes database
http://sis.agr.gc.ca/cansis/nsdb/slc/v3.2/intro.html

Post-fire Soils

Canadian Soil Landscapes database
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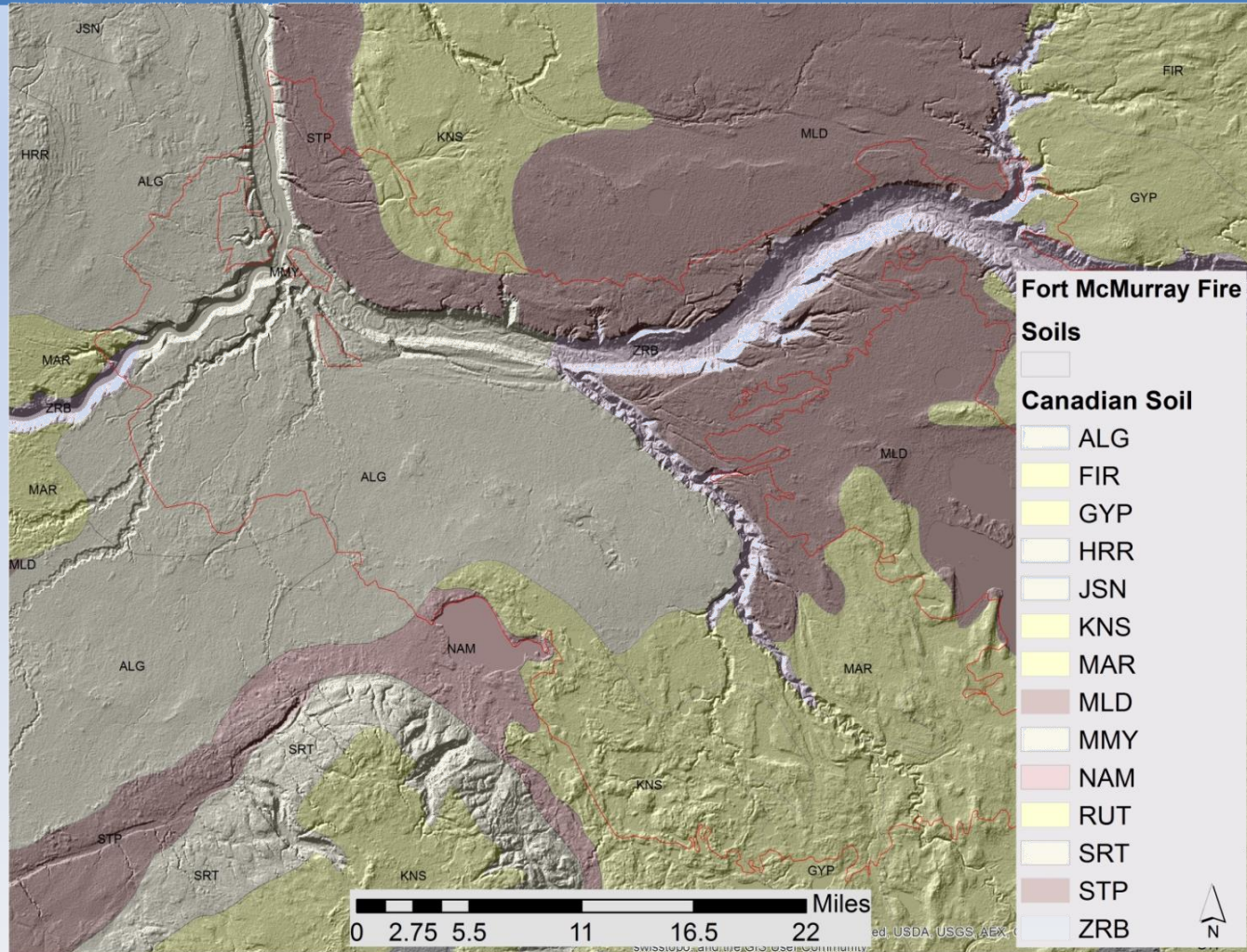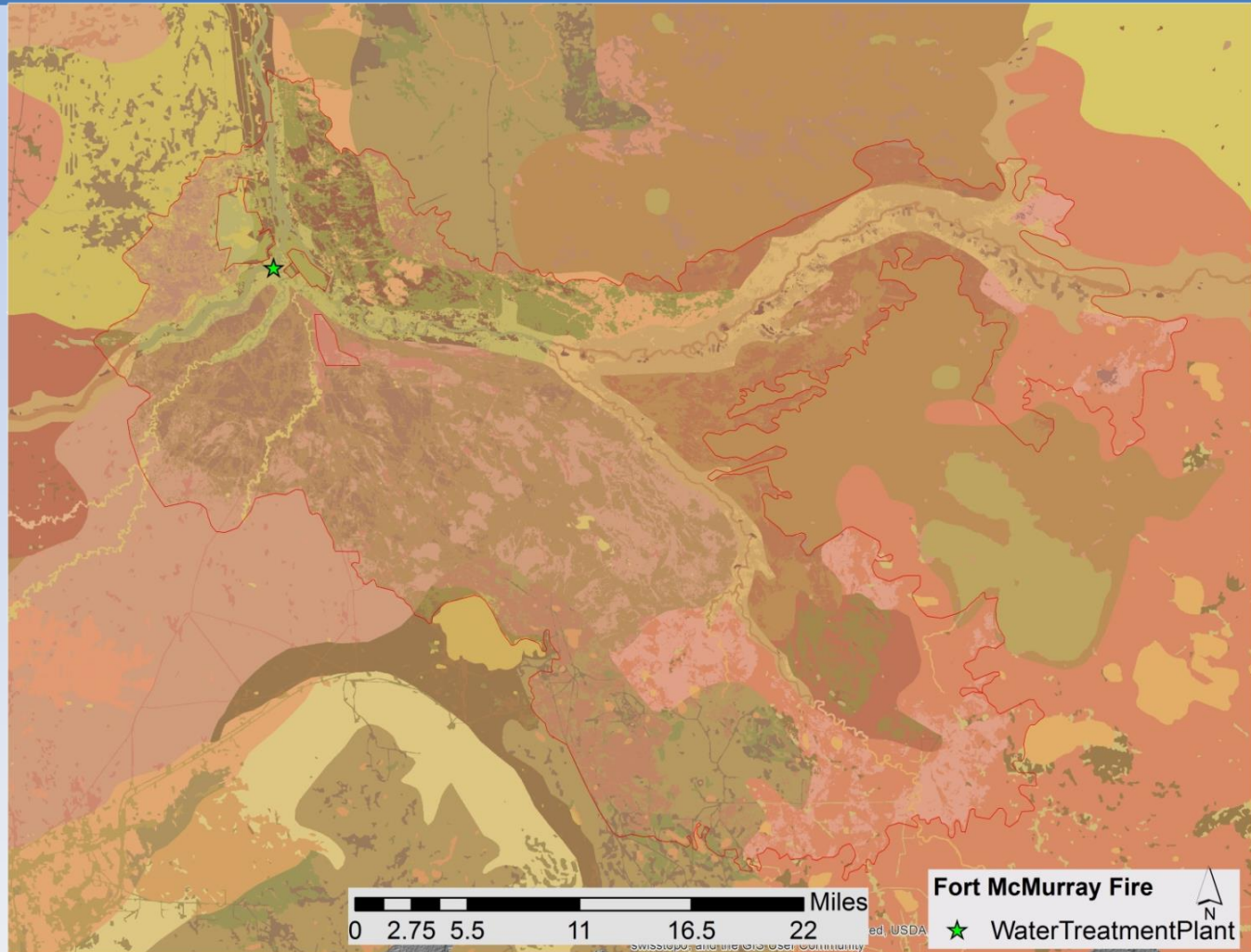
Climate

- For the Fort McMurray fire a 100 year climate file was developed based on nearby weather datasets.

- For the preliminary runs we modeled 5 years of potential first year post-fire weather.
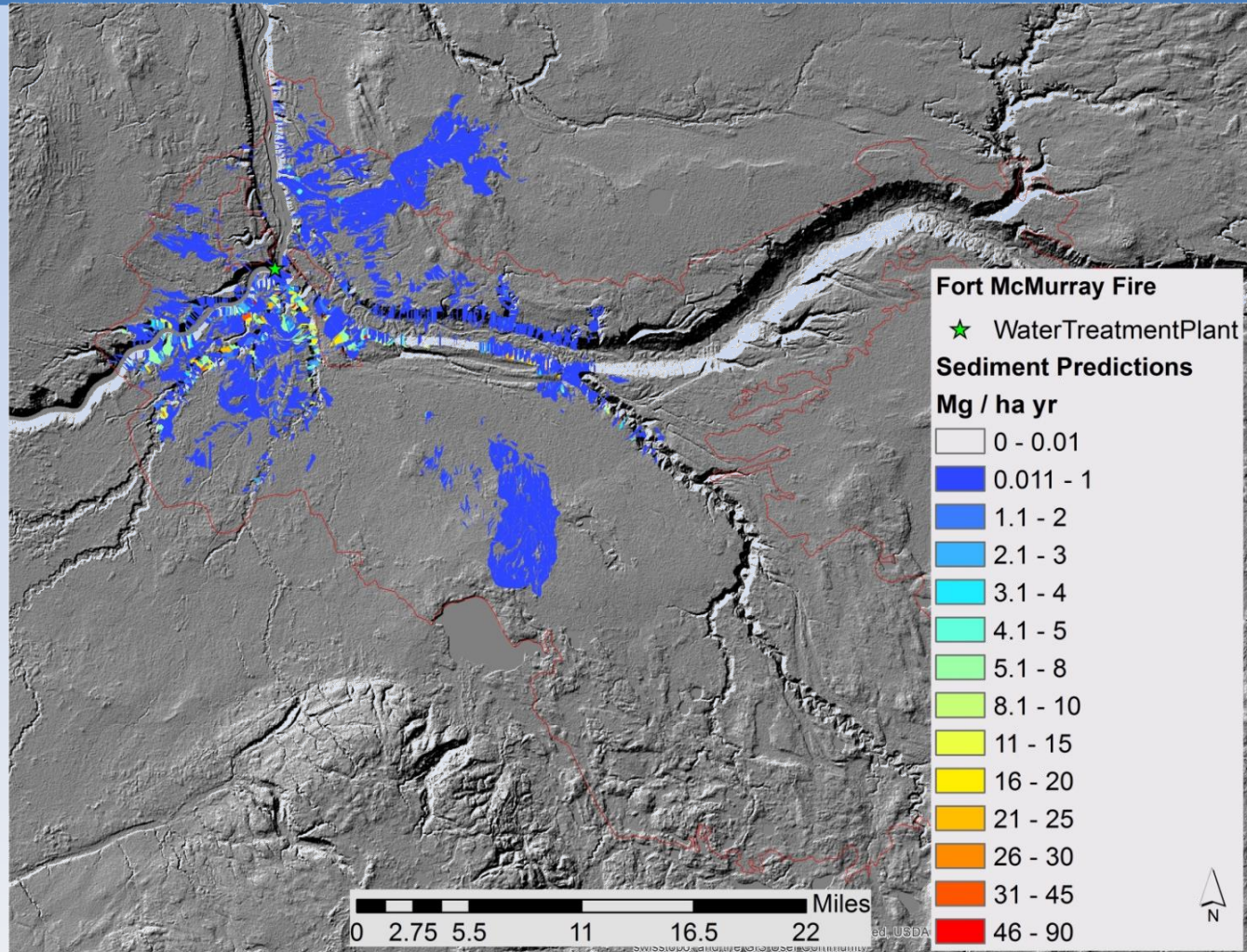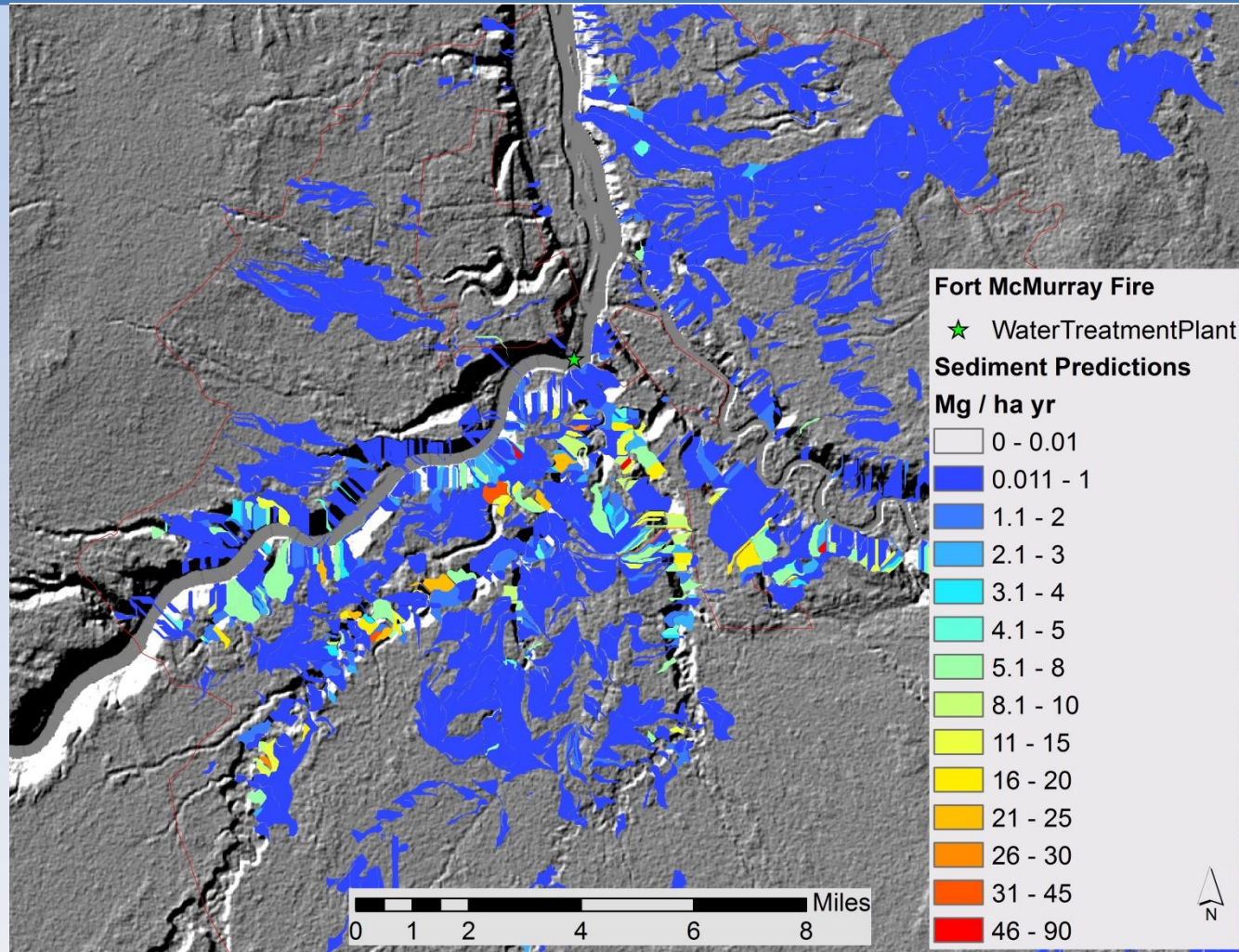
- Average annual precipitation for the modeled 5 years was 31 inches /789 mm.

Results

Results

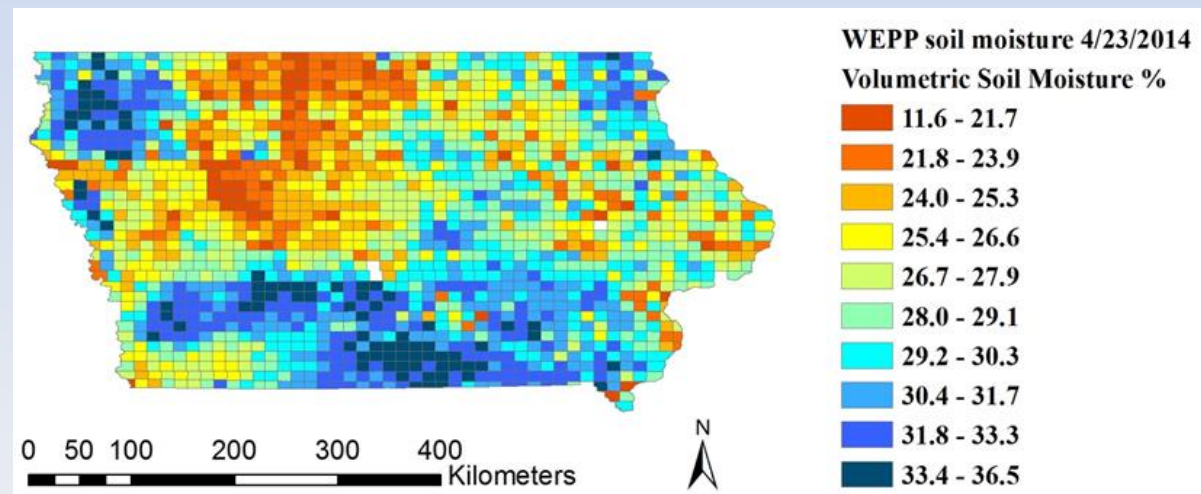# Future Plans for Fort McMurray

- Francois may build on the modeling to predict ash and fine sediments that could impact the water intake for his PhD dissertation

- May use the site to explore sharpening SMAP and sentinel soil moisture data with hydrological modeling.

WEPP-predicted volumetric soil water for 4/23/2014 downloaded from the Iowa Daily Erosion Prediction Project (Cruse et al., 2006).
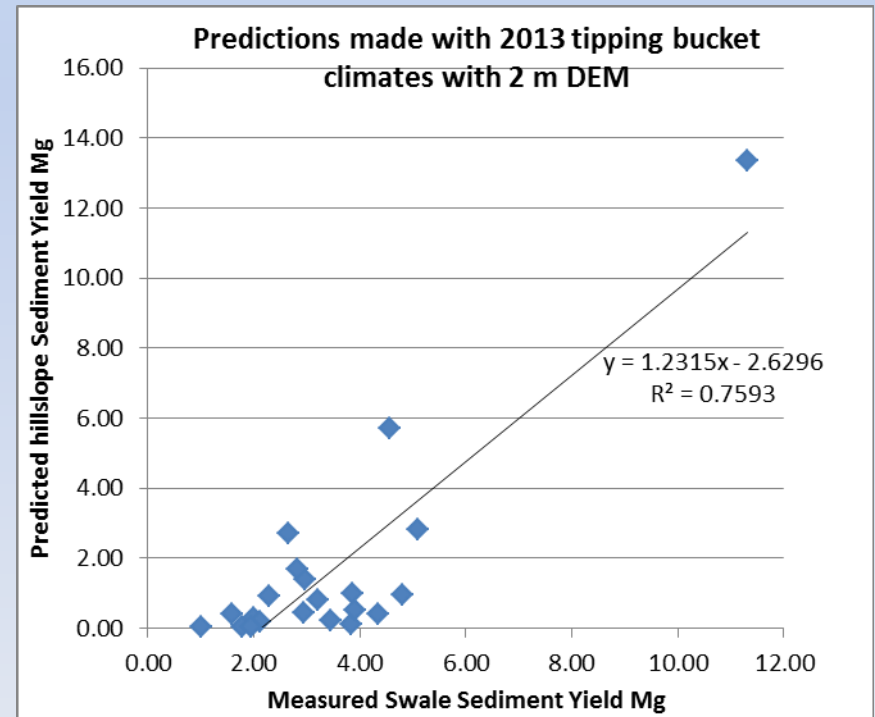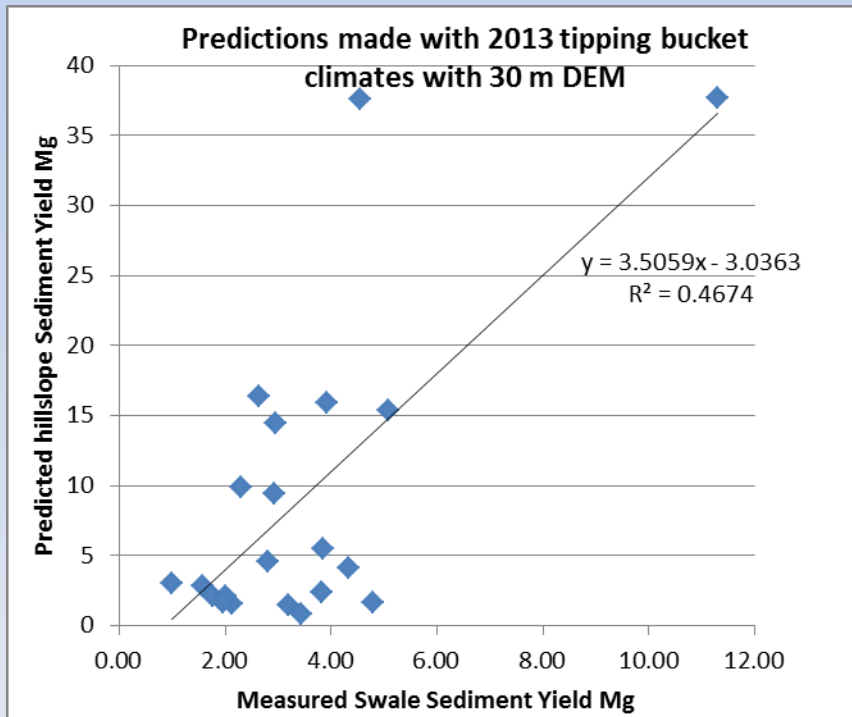
High Park Fire Validation
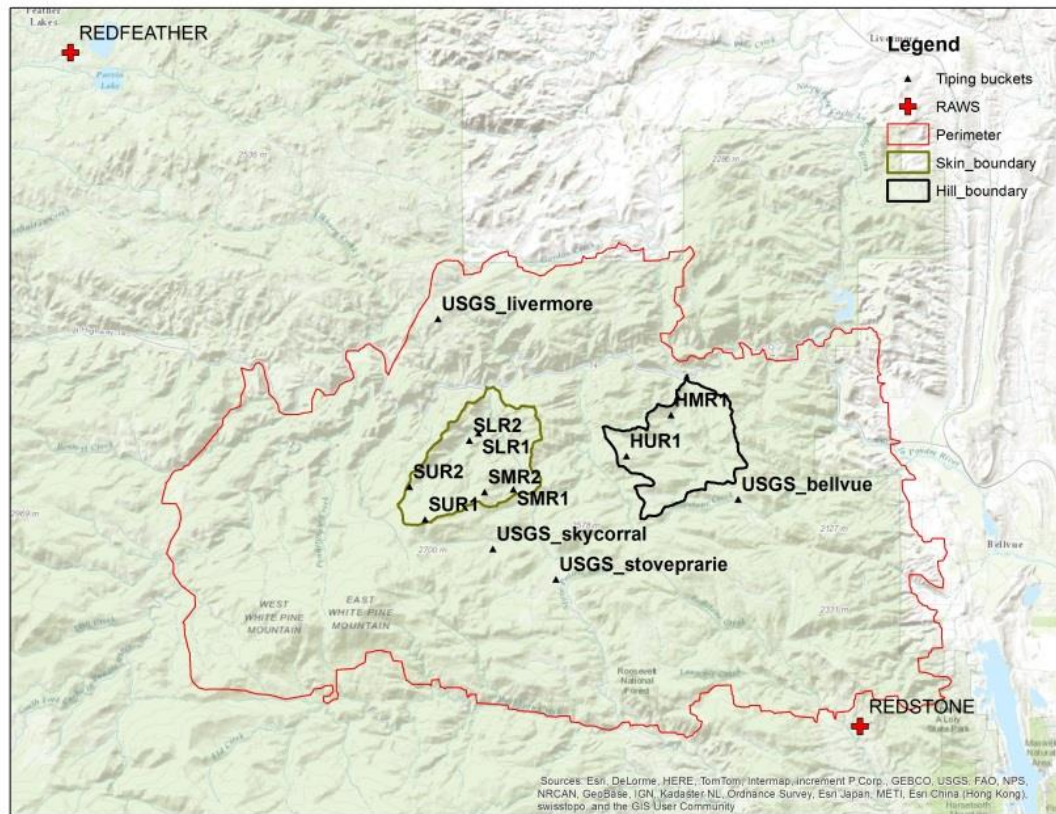
| WEPP climate file	2012 precip (in)	2013 precip (in)	2014 precip (in)
Redfeather_Bellvue	8.49	20.02	16.29
Redfeather_HLR1	8.75	22.5	18.38
Redfeather_HMR1	8.92	24.71	19.63
Redfeather_HUR1	8.4	23.14	17.58
Redfeather_Livermore	7.13	13.38	13.96
Redfeather_Masonville	8.09	18.54	14.35
Redfeather_Sky_Corral	8.31	19.84	15.4
Redfeather_SLR1	9.12	26.28	20.33
Redfeather_SLR2	9.27	24.02	18.95
Redfeather_SMR1	9.16	27.12	22.92
Redfeather_Stove_Prairie	8.19	18.86	14.5
Redfeather_SUR1	10.01	14.46	n/a
Redfeather_SUR2	8.56	19.17	15.84

Sediment fence data from CSU:
Dr. Lee MacDonald, Dr. Stephanie Kampf
Sarah Schmeer

High Park Fire Validation

Spearman's rank correlation for the BAER storm demonstrated rank order between predictions and observations tended to agree with an alpha of 90%.

High Park Fire Validation
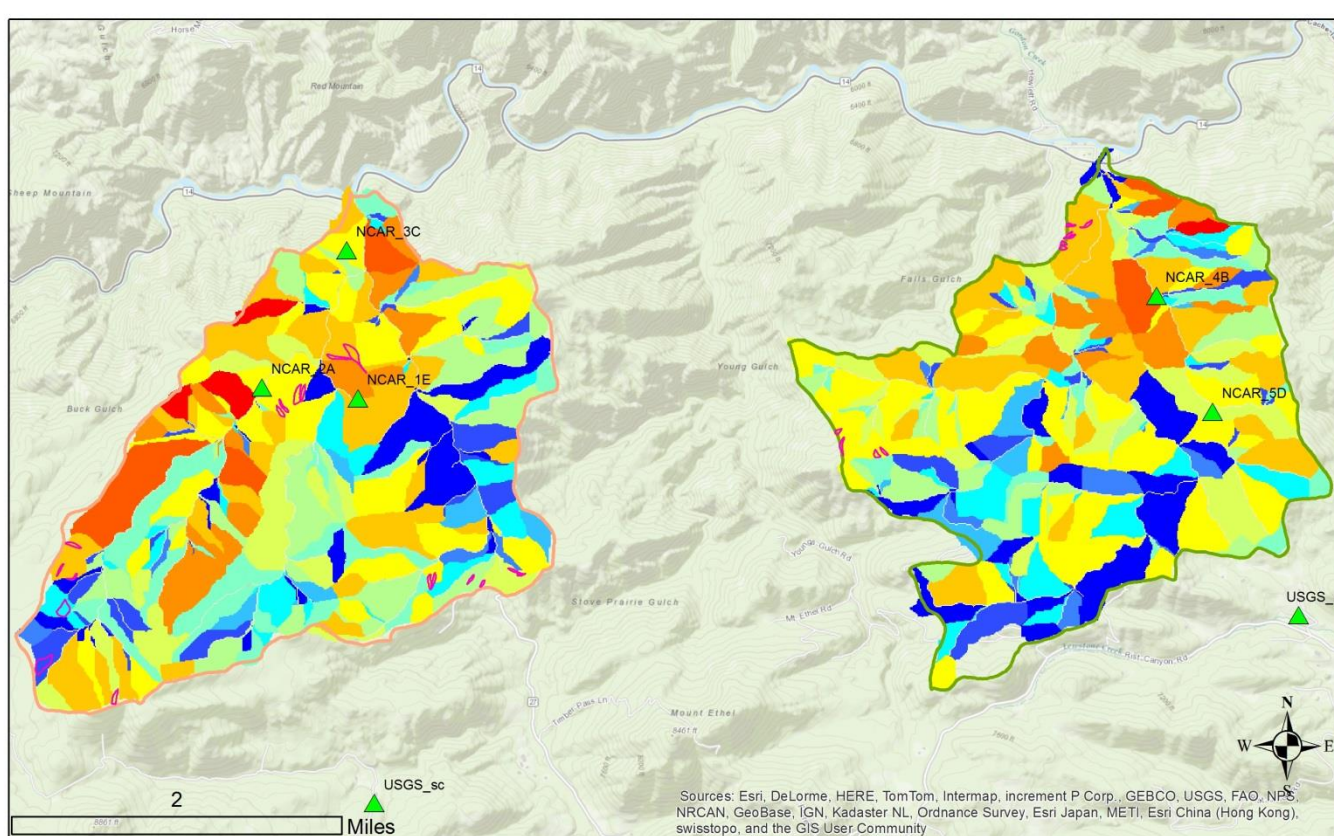
Socioeconomic Impact
Butte Fire (287 km^2)

- Butte fire, CA
  - BLM spent more than $3 million on mitigation treatments, justified and targeted using modeling products made possible by our NASA BAER program (William Haigh, BLM, Personal communication, 6 January 2016).

Photo provided by: Bill Haigh

- King fire, CA
  - USDA Forest Service BAER Team used modeling to target $1 million in mulching. Model results were used to justify costs of treatments some of which was paid for by the Sacramento Municipal Utility District to protect one of their hydroelectric and water supply reservoirs downstream of the fire (Jeff Tenpas, USFS Region 5, Personal communication, 10 April, 2015).

Thank you

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Questions?

http://geodjango.mtri.org/geowepp